Ammonium Hydroxide

Processing

Identification

Chemical Name(s):
Ammonium hydroxide
Other Names:
Aqua ammonia, ammonia water, aqueous ammonia, Spirit of Hartshorn

CAS Number:
1336-21-6 (ammonium hydroxide)
7664-41-7 (ammonia)
Other Codes:
International Numbering System: INS 527
RTECS: BO0875000
DOT ID: 2672 60 (12-44% solution)
2073 15 (44+% solution)

Summary of Advised Recommendation*

Synthetic / Non-Synthetic:	Allowed or Prohibited:	Suggested Annotation:
Synthetic	*Prohibited*	*none.*

Characterization

Composition:
NH_4OH (or $NH_3 \cdot H_2O$)

Properties:
Colorless liquid, intense, pungent, suffocating odor; acrid taste; strong alkaline reaction; dissolves copper, zinc; fumes are formed when ammonia water is brought near volatile acids; forms exothermic reaction with sulfuric acid; infinitely soluble; specific gravity 0.9 (28% NH_4OH) at 25° C; pH 11.6 (1.0N solution); boiling point ca. 36°C (ca. 97F); melting point –72C (-98F); stable under ordinary conditions of use and storage.; produces low temperatures by its own evaporation.

How Made:
Ammonia is produced by a number of different processes. Historically, one of the oldest, and basis for most currently used methods is the Haber-Bosch process, where natural gas is used to convert atmospheric nitrogen to ammonia (Budavari, 1996). This can be characterized as:

$$N_2 + 3H_2 \leftrightarrow 2NH_3$$

Industrial-scale production requires the maintenance of high temperatures, generally in the range of 700°K to 900°K (427°C - 627°C or 800°F - 1,160°F). Processes generally involve the direct reaction of disassociated hydrogen and nitrogen atoms over a catalytic surface coated with a metallic iron. Ammonium hydroxide is produced by the addition of the resulting ammonia to water.

$$NH_3 + H_2O \leftrightarrow NH_4^+ + OH^-$$

This reaction is reversible. The existence of undisassociated ammonium hydroxide (NH_4OH) is considered doubtful, but aqueous solutions of ammonia are basic and behave similarly to metal cation hydroxides, such as sodium hydroxide (Czuppon, Knez, and Rovner, 1992). Ammonium hydroxide has an NH_3 equivalent weight of 48.59 (EPA, 2000).

* *This Technical Advisory Panel (TAP) review is based on the information available as of the date of this review. This review addresses the requirements of the Organic Foods Production Act to the best of the investigator's ability, and has been reviewed and commented on by experts on the TAP. The substance is evaluated against the criteria found in section 2119(m) of the OFPA (7 USC 6517(m)). The information and advice presented to the NOSB is based on the technical evaluation against that criteria, and is not intended to incorporate commercial availability, socio-economic impact, or any other factor that the NOSB and the USDA may want to consider in making their decisions.*

Most commercial solutions of 28-29% NH_3 in water, although 44% solutions of NH_3 are marketed for food processing use.

Specific Uses:
Ammonia is one of the top industrial chemicals produced in the world. The hydroxide form is petitioned for use as a boiler water additive, but it is also used in processing as a direct food ingredient for leavening, pH control, and as a surface-finishing agent (Lewis, 1989). Ammonium hydroxide is also used to extract food colorants and dyes (Budavari, 1996). Other uses in food processing facilities are as a refrigerant, cleaning agent, wastewater treatment, and reactant, for example, as a starter for a cheese culture (EPA, 1998). Ammonia is also released as a by-product of a number of food processing activities (EPA, 1998).

Ammonia is a precursor to synthesize amino acids, and is used in animal feeds by itself as a nitrogen source. One of the largest uses of ammonia, by production volume, is as a fertilizer, including the ammonium hydroxide form. The review will focus on the ammonium hydroxide form, and the petitioned use as a boiler water additive but some of the other forms, uses, and applications will also be addressed as relevant to the TAP review.

Action:
Ammonia in solution is alkali in pH, and ammonia (NH_3) reactive. Neutralizes carbonic acid in condensate to prevent corrosion. Used as a boiler additive to neutralize carbonic acid in condensate thus preventing corrosion to boiler equipment. The petition was for use as a boiler water additive. Ammonia is a precursor to amines, will form amines under certain conditions in the presence of certain other co-reactants, and functions similarly to the volatile amines but ammonium hydroxide is technically not a volatile amine.

Combinations:
Contained in an aqueous solution. Food processing applications are numerous. As a boiler water additive, may be with other volatile amines, such as cyclohexylamine, diethyleneaminoethanol (DEAE), morpholine, and octadecylamine. Combined with other yeast nutrients, with various animal feed ingredients such as molasses, and as a precursor to amino acids for use in livestock feed, as nutritional supplements, and for other applications. It is also used in the manufacture of animal drugs. Ammonia is also used with a variety of cleaners, sanitizers, and disinfectants (Czuppon, Knez, and Rovner, 1992). It is also a waste product in effluent from a number of food processing operations (EPA, 1998).

The largest single use of ammonia has long been as an ingredient in fertilizers (NRC, 1978; Czuppon, Knez, and Rovner, 1992; Johnson, 2000). The next largest use is as a precursor to polymers and to make explosives (Czuppon, Knez, and Rovner, 1992). Applications to the textile industry are also significant. It is also used to tan hides, and is an ingredient in moth-proofing and preservative compounds for leather and furs. It is also widely used in a number of cosmetics (Czuppon, Knez, and Rovner, 1992). Ammonia is used to make or in combination with a large number of industrial chemicals (Czuppon, Knez, and Rovner, 1992).

Status

OFPA
May be added to the National List as equipment cleaner (7 USC 6517(c)(1)(B)(i).
Prohibited as a synthetic nitrogen fertilizer (7 USC 6508(b)(2)).

Regulatory
FDA CFR Title 21, Subpart B, Sec. 582.1139 Generally Recognized as Safe (GRAS) is discussed below.

EPA / NIEHS / Other Appropriate Sources

EPA –
FIFRA: Residues of ammonium hydroxide are exempted from the requirement of a tolerance when used as a solvent, co-solvent, neutralizer, or solublilizing agent in accordance with good agricultural practices as inert (or occasionally active) ingredients in pesticide formulations applied to growing crops or to raw agricultural commodities after harvest. Also appears on EPA List 3.

CERCLA: Ammonium hydroxide is considered a Hazardous Substance under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (40 CFR 302.4).

SARA/EPCRA: The substance appears on the Superfund Amendments and Reauthorization Act (SARA) Title III and Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) List of Extremely Hazardous Substances (40 CFR 355 Appendix A). It is also subject to SARA reporting requirements contained in 40 CFR 311 and 40 CFR 312. Manufacturers of CHA are subject to Superfund requirements in 40 CFR 313. Ammonia use presents a number of special considerations for food processors to consider (EPA, 1998). Given the numerous uses and sources, special guidance is required for reporting aqueous ammonia (EPA, 2000).

CWA: Ammonia discharges from certain types of meat processing facilities are regulated under the Clean Water Act (40 CFR 432.45 *inter alia*).

CAA: Does not appear on the Clean Air Act list of Volatile Organic Chemicals.

NIEHS - The National Toxicology Program does not consider ammonium hydroxide to be a carcinogen. The NTP database does not include data on either ammonia or ammonium hydroxide. The NOSB may want to consider supporting a petition to have the NTP review ammonia and ammonium hydroxide.

Other sources -
Occupational Safety and Health Administration (OSHA) revised the limits for Final Rule on Air Contaminants Project (54 Fed Reg. 2324). This rule was remanded by the U.S. Circuit Court of Appeals and the limits are not currently in force. OSHA's former exposure limit for ammonia was 50 ppm as an 8-hour TWA [Time Weighted Average]. OSHA proposed to revise this limit to 25 ppm TWA and to add a 35-ppm 15-minute short-term exposure limit (STEL), based on the limits established by the ACGIH. However, in the final rule, the Agency has determined that it is not appropriate to establish a 25-ppm TWA limit for ammonia; the final rule does revise OSHA's exposure limit to 35 ppm as a 15-minute STEL. . .

Ammonia is a primary eye and upper respiratory tract irritant. Ammonia concentrations in the range of 20 to 25 ppm elicited complaints of discomfort from workers engaged in blueprinting and copying operations (Detroit Department of Health, 1986). Pigs exposed to ammonia also showed systemic effects (Stombaugh et al., 1969). Thus the ACGIH established both a full-shift TWA of 25 ppm to protect against chronic effects and a 35-ppm STEL to protect against ammonia's irritant effects.

OSHA also considered NIOSH's recommended 5-minute ceiling limit for ammonia of 50 ppm. NIOSH relied on several reports that ammonia concentrations as low as 50 ppm are moderately irritating. Their findings concluded that the "irritating or annoying effects...[of exposure to ammonia are] more dependent upon concentration than length of exposure," and that "a standard expressed as a time-weighted average is inappropriate since it would permit fluctuations to concentrations considerably higher than 50 ppm.(NIOSH, 1974).

Some workers experience eye and upper respiratory tract irritation. For example, one source cites that 5-minute exposures to 32 ppm caused nasal dryness in 10 percent of exposed volunteers, and that 5-minute exposures to 50 ppm ammonia caused nasal irritation and dryness in 20 percent of exposed volunteers (Proctor, Hughes, and Fischman).

Pigs exposed continuously to between 103 and 145 ppm ammonia reduced their consumption of food and lost weight (Stombaugh, Teague, and Roller, 1960 cited in ACGIH, 1986). The ACGIH interprets this study to mean that systemic toxicity occurs as a result of chronic exposure to ammonia. However, OSHA interprets this study differently, believing instead that it shows a secondary effect of the irritation traditionally associated with ammonia exposure. OSHA considered this as evidence that the pigs were experiencing too much respiratory and eye irritation to be interested in their food (OSHA, 1989). OSHA concluded that the eye and upper respiratory tract irritation associated with ammonia exposure constitute material impairments of health and pose a significant risk to exposed workers.

Status Among U.S. Certifiers
Most US certifiers do not include it on their materials lists, and prohibit boiler water additives according to the Organic Good Manufacturing Practices established by the NOSB in 1995. Oregon Tilth Certified Organic classifies ammonium hydroxide as 'regulated' but this appears to be unique among certifiers worldwide. See the discussion regarding boiler water additives in the background paper Steam Generation in Organic Food Processing Systems (Steam Paper).

International

Canada – Not included in the list of permitted non-organic additives substances for organic food products (CGSB, 1999).

CODEX- Not in Annex 2, Table 4, 'Processing Aids' (FAO/WHO, 1999).

EU 2092/91 – Not in Annex VI, 'Processing Aids' (EU 2092/91).

IFOAM – Not on Appendix IV, approved processing aids and other products (IFOAM, 2000).

Japan — Not on the list of approved food additives (Woolsey, 2000).

OFPA 2119(m) Criteria

1. *The potential of such substances for detrimental chemical interactions with other materials used in organic farming systems.*
   As this is a processing material, the substance is prohibited from synthetic sources for use in organic farming systems as a synthetic nitrogen source. Use from natural sources (e.g. manure) is generally restricted. Chemical interactions within a processing environment is discussed in the Steam Paper.

2. *The toxicity and mode of action of the substance and of its breakdown products or any contaminants, and their persistence and areas of concentration in the environment.*
   See processor criteria 3 below.

3. *The probability of environmental contamination during manufacture, use, misuse or disposal of such substance.*
   This is considered below under item (2).

4. *The effect of the substance on human health.*
   The effects of ammonia on human health have a vast literature associated with it. Two of the best summaries have been prepared by the National Research Council's Committee on Medical and Biologic Effects of Environmental Pollutants (1979) and the World Health Organization's International Programme on Chemical Safety (1986). The TAP review will limit consideration of those factors related to the effect on nutrition (3) below as well as the consideration of GRAS and residues (5) below.

5. *The effects of the substance on biological and chemical interactions in the agroecosystem, including the physiological effects of the substance on soil organisms (including the salt index and solubility of the soil), crops and livestock.*
   Ammonia's chemical interactions in the agroecosystem and physiological effects on soil organisms are the subject of significant study (NRC, 1979) but is beyond the scope of the petitioned processing use. While some food handling uses may result in the release of significant amounts of ammonia into the agroecosystem, this TAP review assumes that disposal takes place outside the organic farming system.

6. *The alternatives to using the substance in terms of practices or other available materials.*
   See discussion of alternatives in the Steam Paper.

7. *Its compatibility with a system of sustainable agriculture.*
   This is considered more specifically below in the context of organic handling in (6) below.

Criteria from the February 10, 1999 NOSB Meeting

A PROCESSING AID OR ADJUVANT may be used if;

1. *It cannot be produced from a natural source and has no organic ingredients as substitutes.*
   Ammonia is naturally occurring in foods at low levels in both aqueous and ammonium hydroxide forms. It is commonly found in manure and decaying organic matter. However, all commercial sources are synthetically manufactured from atmospheric nitrogen, usually using natural gas as a fuel source.

   As for substitutes for the petitioned use, steam can be produced from water without the addition of boiler water additives. A list of substances that are FDA approved for boiler water contact is attached. When considering chemical means to condition steam lines in boiler systems, the additives to the steam lines must be volatile, so that they purposely travel along with the steam. There are no known non-synthetic boiler additives that can serve this purpose. The alternatives are discussed in greater depth in the Steam Paper.

2. *Its manufacture, use, and disposal do not have adverse effects on the environment and are done in a manner compatible with organic handling.*
   Ammonia production does not generate any significant waste stream. Production of ammonia requires a significant energy input to drive the synthetic reaction (Budavari, 1996). Ammonia production—primarily for fertilizer—continues to account for one of the largest uses of energy of all chemicals produced (Johnson, 2000). Coal production methods may cause significant air pollution. About two-thirds of all ammonia production involves the use of natural gas as a fossil fuel (Czuppon, Knez, and Rovner, 1992).

   Ammonium hydroxide is an irritant and must be handled properly. There are significant worker health issues that could be a problem if it is improperly handled. Exposure to humans and other mammals by ammonium hydroxide is a serious toxicological concern. It is toxic by all routes (inhalation, ingestion, and dermal contact (Toxnet, 2001). Various published guidelines for use of this material all prescribe the use of protective equipment, for eyes, lungs, skin, and ingestion (NIOSH, 1979; NTP, 2001). Short-term exposure can result in irritation of the eyes, throat, skin, and mucous membranes, as well as dyspnea, bronchspasm, and pulmonary edema; ingestion can cause burning pains in the throat, mouth, stomach, and thorax; brief exposure to higher concentrations (5000 ppm) can be fatal (Budavari, 1996; Chermishinoff). Long-term exposure can result in chronic irritation to the eyes and respiratory tract (NIOSH, 1978).

   Ammonium hydroxide produces a pungent odor that is an irritant. It is an air and water pollutant. For example, ammonia is considered a greenhouse gas (NRC, 1978). Ammonia produced as the effluent of sparged boiler water is a potential water pollutant. Ammonia is a plant nutrient. As an effluent, it will favor some species over others and may be a factor in contributing to eutrophication (NRC, 1978). Ammonia is also toxic to fish and other aquatic animals (IPSC, 1986).

3. *If the nutritional quality of the food is maintained and the material itself or its breakdown products do not have adverse effects on human health as defined by applicable Federal regulations.*
   Acute oral exposure and ingestion are linked to liver damage (NRC, 1978) and hepatic coma (IPCS, 1986). Ammonium hydroxide has an acrid taste, and can affect the flavors of foods; as it participates in a strong alkaline reaction with a variety of materials, the resultant products can be made bitter. Ammonia has a pungent odor and imparts a distinct flavor defect, even at relatively low rates. For example, the threshold value for detection in water is 3.4 x 10+1 or about 35 ppm (Fazzalari et al., 1978, cited by petitioners; supported by IPCS, 1986).

   The full effects of reactions between ammonium hydroxide and foodstuffs are not as well documented as other forms of exposure in the scientific literature (NRC, 1978; IPCS, 1986). There is substantial disagreement among researchers as to the long-term effects of exposure (IPCS, 1986). It would appear that it has minimal adverse effects on human health if used as intended (IPCS, 1986). However, there have been incidents and indications that ammonia can have documented adverse effects on human health at relatively low levels, not far above the levels at which workers and consumers could potentially be exposed. Accidental exposure is also a possibility when a chemical is being handled in a food processing operation. Ammonia will form nitrates and nitrites under certain conditions (NRC, 1978). Nitrates and nitrites are prohibited by the Organic Foods Production Act (7 USC 6510(a)(3)).

The Federal Centers for Disease Control reported that the accidental release of ammonia resulted in non-lethal acute poisoning of schoolchildren from consumption of contaminated milk. These children reported severe burning of the mouth and throat, as well as nausea. The symptoms developed within 1 hour of drinking the contaminated milk (CDC, 1986). There has been a noted case where milk was contaminated by ammonium hydroxide during processing (CDC). Especially when considering that the ammonium hydroxide would be contacting foodstuffs under heated conditions, reactivity is likely in at least some cases. The reaction of this synthetic material with organic foodstuffs may create a variety of synthetic by-products, the health implications of which are not completely known, especially over the long-term.

There is no indication that addition of aqua ammonia to the processing stream has a beneficial effect on the nutritional quality of food. The petition does not provide a food safety benefit for allowing its use. Furthermore, ammonium hydroxide is a good solvent for many materials, including certain metals such as copper and zinc (Budavari, 1996), which could result in the toxic accumulation of these metals in organic food products, if the material is not used with caution, or is used in incompatible steam systems.

Ammonium hydroxide is an eye and respiratory tract irritant. Another characteristic is that under certain common conditions, aqueous ammonia can damage metals and cause rather than prevent corrosion (Bradford, 1993). For example, ammonium hydroxide is corrosive of copper and zinc (Budavari, 1996). Ammonia in high pH systems or beyond the optimum level will actually increase the amount of copper in boiler water copper-nickel systems above a zero-treatment control (Burgmayer, 1989). While copper and zinc are essential trace elements, both can be toxic in excess. This is a concern where copper or zinc are used as either sacrifice coatings or as the primary materials in the waterside wall of boilers. Ammonia will also react with chlorine-based disinfectants in water to form chloramines (EPA, 1998).

4. *Its primary purpose is not as a preservative or used only to recreate/improve flavors, colors, textures, or nutritive value lost during processing except in the latter case as required by law.*
The petitioned use is not to change the quality of the food, but rather to maintain and prevent corrosion of the boiler and steam line equipment used to produce steam that is in contact with the food. Ammonium hydroxide as a boiler water additive is not intended to have any technical or functional affect on the food product. If used, however, some of the material will come into contact with organic foods, thus the reason for the petition. Other uses will have a functional effect, such as in chocolate processing, as an extractant for glycyrrhizin (licorice); and as a synthetic nitrogen source in a feed additive. These functions are not covered in the TAP review.

5. *Is Generally Recognized as Safe (GRAS) by FDA when used in accordance with Good Manufacturing Practices (GMP), and contains no residues of heavy metals or other contaminants in excess of FDA tolerances.*
Ammonium hydroxide is listed as GRAS by FDA (21 CFR 184.1139) food with no limitation other than current good manufacturing practices for the following uses:

Leavening agent	21 CFR 170.3(o)(17)
pH control agent	21 CFR 170.3(o)(23)
surface-finishing agent	21 CFR 170.3(o)(30)
boiler water additive	21 CFR 173.310
Feed additive	21 CFR 582.1139.

FDA requires that as an ingredient used in food it cannot exceed levels used in current good manufacturing practice. When used as a boiler water additive, levels also are not to exceed current good manufacturing practice. The GMPs do not cite a quantitative level that can be carried over in steam, in contrast to some of the other boiler water additives that have been petitioned.

6. *Its use is compatible with the principles of organic handling.*
As a general rule, ammonia products are not considered compatible with organic production or handling. The NOSB considered the issue of boiler chemicals in 1995, and determined that boiler water additives are not allowed to be in live steam that is in direct contact with organic food. While this did not specify

ammonia and volatile amines, this particular application was excluded for use. All organic production and processing certification standards are based on the premise that synthetic toxic substances should not be used in a way that brings them in contact with organic foods.

As ingredients in processed food products, an exception was made to ammonium carbonates used in baked goods. However, the NOSB voted to prohibit ammonium phosphate and ammonium soaps in organic handling. The NOSB has already recommended that several be listed. Different additives have different functionalities. As a caustic, sodium carbonates, potassium carbonate, potassium hydroxide, sodium hydroxide.

Ammonium carbonates are on the National List as an alternative yeast food. No petitioner has requested any use other than as a boiler chemical, although some certifiers have reportedly encountered these other uses by processors.

See the Steam Paper and the reviewers' comments below for a further discussion.

7. *There is no other way to produce a similar product without its use and it is used in the minimum quantity required to achieve the process.*
   Live steam can be generated without the use of any boiler chemicals. There are boiler chemicals that are already on the National List. These include other caustics, such as potassium hydroxide and sodium hydroxide. There are methods to keep live steam from coming into direct contact with food. These include the use of heat exchangers, traps, filters, and other equipment. See the Steam Paper for further discussion.

TAP Reviewer Discussion*

TAP Reviewer Comments

Reviewer 1 *[Food Science and Nutrition Professor with inspection and certification experience]*

Ammonium hydroxide NH_4OH is considered a strong alkali which is manufactured from both natural gas and atmospheric nitrogen to ammonia gas which is readily soluble in water at concentrations of 28 to 44%. Most ammonium hydroxide is marketed to food processing operations at 44% being more concentrated which reduces the liquid handling and shipping cost of water, but presents perhaps more of a dangerous environmental impact issue should spillage occur.

Ammonium hydroxide is considered a neutralizing amine with the highest distribution ratio of 10 when compared to the other neutralizing volatile amines (Betz, 1980). This means it has a greater percentage in the vapor phase rather than the aqueous phase. Therefore its effectiveness may be based on its distribution ratio. This may be the main argument as to why the industry has not embraced the options of using sodium carbonate, sodium bicarbonate, potassium carbonate, potassium hydroxide or sodium hydroxide. However, if boiler feed water is deaerated followed by ion exchange, these alternatives may be as effective since the internal rate of corrosion of steam lines will be reduced. However, if optimization of alternatives is considered coupled with boiler feed water treatments, then a satisfactory solution or alternative is provided.

Overall, the toxicity of ammonium hydroxide and gaseous ammonia is well documented as eye and respiratory tract irritant. In the baking industry, ammonium bicarbonate decomposes to ammonia gas and carbon dioxide and serves as leavening agent for cracker food products. However, the ammonia gas must be exhausted or ammonium hydroxide will form which will cause a yellow discoloration of the wheat flour based cracker as well as contribute to a strong, astringent off flavor in the product.

Since there are no FDA limitations on its use, the potential for excessive use exists resulting in high concentrations of ammonia in the steam (i.e. greater than 25 ppm). Therefore due to environmental and worker safety issues, toxicity issues and the potential for direct contact (as with all volatile amine boiler additives) of ammonium hydroxide to organic food products, I recommend that it be prohibited for all organic food processing operations where there is direct steam contact with the food.

---

* *OMRI's information is enclosed in square brackets in italics. Where a reviewer corrected a technical point (e.g., the word should be "intravenous" rather than "subcutaneous"), these corrections were made in this document and are not listed here in the Reviewer Comments. The rest of the TAP Reviewer's comments are edited for identifying comments, redundant statements, and typographical errors. Any text removed is identified by ellipses [. . .] Statements expressed by reviewers are their own, and do not reflect the opinions of any other individual or organization.*

Summary Recommendation:
1. Synthetic
2. Prohibited
3. Suggested annotation: for processing operations where there is direct steam or food contact.

Reviewer 2 *[Consultant to organic certifiers]*
Although ammonia does result from natural fermentative processes and can be found in nature as such, collection of the gas from these sources for use in processing systems is not practical and not done. For the purposes of this TAP review, ammonium hydroxide is considered a synthetic material.

*[A]*mmonium hydroxide . . . *[is used]* as an additive to steam *[that]* comes into direct contact with organic foods during processing. The function of the aqua ammonia is to neutralize carbonic acid which forms from the steam generation system; neutralization of the acidic condensate stream reduces corrosion of boiler equipment most notably steam lines.

Ammonium hydroxide may be used in the synthesis of other compounds which might subsequently be used in food processing, such as leavening agents. Such materials should be deemed beyond the scope of this review. The NOSB has already reviewed some such materials which the NOP placed on the National List (ammonium carbonate and ammonium bicarbonate) as allowed non-organic ingredients for processing organic foods. Other ammonium compounds have traditionally been prohibited in organic production systems, for agriculture, livestock, and processing applications. The only noted exception in the NOP rule is the allowance of ammonium carbonate in insect traps (no contact with soil or crops allowed). (7 CFR 205)

Comments on the Criteria
Organic certifiers in the United States, if they take a position at all on this issue, are consistent in repeating the prohibition recommended by the NOSB. The NOSB did make exceptions to this by allowing ammonium carbonate and ammonium bicarbonate as leavening agents, but has recommended prohibitions on other ammonium products. The reason for the exceptions made for the leavening agents is unknown to this reviewer, but judging by the processing techniques and materials available to processors of organic foods, it would seem more consistent if those materials were also removed from the National List. Adding another ammonium product does not seem compatible, especially given the other considerations mentioned in this review.

Live steam can be and is produced in many processing systems without the use of any boiler additives that carry over onto the food products. Boiler water can be treated in advance of use in the system by a variety of methods to soften, deionize, filter, and otherwise purify it. These steps reduce the need for addition of synthetic materials not on the National List to the boiler system. In some applications, the steam or heating system for the food may be changed to one where live steam is not the active agent, but rather heating (of food contents directly, or of steam in contact with food) is done via a heat exchange system. The wide variety and individuality of processing systems which exist is indicative of the many ways in which the full range of processed food products can be made without the need for toxic boiler additives to be used in contact with organic foods. This reviewer does not know of any food product type that absolutely requires ammonium hydroxide in steam which contacts organic food.

Justification of use of ammonium hydroxide by the petitioners is based on the constraints of their particular boiler and steam systems as they currently exist, and on the financial and/or logistical challenges involved with changing those systems so as to avoid contact of the organic food by the aqua ammonia. However, economic considerations are clearly not one of the criteria (either in OFPA or the final NOP rule) for determining the suitability of materials used in organic production systems.

History shows that quite often it has been the case that an organic operator (producer or handler) has had to make substantial changes to their system in order to be compliant with organic standards. These changes often involved redesigning of systems, practices, and techniques. In many cases, such changes resulted in the need for financial investment, as well as an investment in time. Some creativity on the part of the operator was often needed, to devise a new system. This has indeed been the case for certain processors, who made adjustments to their boiler systems or manufacturing practices in order to comply with the prohibition of contact of organic foodstuffs by synthetic boiler chemicals. The inconvenience of having to retool or readjust systems should not be the determining factor in whether or not such materials are added to the National List.

For certain processors, where organic processing events are not frequent, the boiler may be operated without the ammonium hydroxide for a limited time, without significant affect on the boiler or steam line system. For these operations, no retooling may be needed; instead, a procedure can be designed whereby it is verifiable that the volatile boiler chemical has been exhausted from the system prior to handling the organic goods.

For processors who intend to process frequently enough, or for long enough run times, redesigning of the system will be necessary, in one way or another. Prohibition on the use of volatile boiler chemicals can exist without consigning processors to premature deterioration of their equipment. It is often the case in industry that the creative process involved in redesigning systems has unpredicted benefits (short- and long-term) to the operator and the environment, in terms of long-tern cost-effectiveness and sustainability; efforts in this direction should be encouraged, especially if not doing so results in a compromise of organic principles.

In fact, running boiler equipment designed for use with synthetic additives without the additives in place does lead to deterioration, and consequent lower efficiency of the system, which generally means greater energy consumption (Kohan, 1997). While greater efficiency of energy consumption seems undoubtedly to be desirable (both economically and ecologically), energy balance as a whole has not been considered as factor by the NOSB or certifiers when making determinations on the compatibility or allowability of materials or methods. To use such a factor as a criterion in the case for the volatile boiler additive is therefore inconsistent with the rest of the paradigm, and should not be a determining factor at this time.

Summary and Recommendation
Ammonium hydroxide should be deemed a synthetic, prohibited material, and not be added to the National List for any purpose.

Reviewer 3 *[University staff in Food Science with inspection, consulting, and certification experience]*
Ammonium Hydroxide (NH_3) is petitioned for use as a steam additive chemical to reduce corrosion in pipes. There could be direct food contact in many processing operations when steam is used to cook or heat food, such as in a blancher, cooker, canner, or other operations. NH3 has no functionality toward the food.

Comments on the Criteria
[The] . . . environmental impact [of the petitioned use] is likely to be negligible. *[However, g]*enerally ammonium products are not considered compatible *[with organic production and processing]*.

There are other solutions that could be used to produce the desired result (no corrosion of piping). To summarize many of the citations reviewed, 'use of stainless steel piping completely solves the problem of corrosion.’ The justification statement in the petition and the alternative control methods do not mention this as a possible solution. They do mention the costs of capital equipment and provide anecdotal evidence of the life expectancy and replacement needs should boiler water additives not be used, but provide no data to support this. There are numerous tests that can and should be performed periodically to determine the corrosion rates, (even with the use of inhibitors) to insure that equipment is being operated and maintained in a safe and efficient manner. Without confirming studies to show the differences in corrosion rates with and without the use of corrosion inhibitors, it appears that these petitioners are using anecdotal evidence to justify their continued use of cheap toxic chemicals instead of more expensive, but viable alternatives. There are several cited alternatives: stainless steel piping (suitable for all operations); discontinued use during organic processing (some operations); steam to steam heat exchanger (suitable for some operations); secondary boiler for food contact application only (suitable for all operations) that could be used. None of these are necessarily cheap, but all offer a viable alternative to the use of toxic chemicals.

In spite of the minimal health and environmental impact of ammonium hydroxide, alternatives exist with even lower impacts. Because of ammonium hydroxide's GRAS status and minimal health and environmental concerns, I could see reviewing its use with restrictions on concentration, if studies indicate the necessity for its use. Such studies would have to be completed in a timely fashion (1-2 years) and demonstrate a significant improvement in the life expectancy of a boiler and it's piping systems. Studies demonstrating no adverse impact on the composition, flavor or nutritional parameters of the food at the recommended concentrations should also be undertaken prior to granting approval. Additional studies and regulations to insure worker exposure safety should also be included prior to further review.

Conclusion

The reviewers unanimously consider ammonium hydroxide to be synthetic, and unanimously advise the NOSB to not add it to the National List. Use should remain prohibited in organic handling.

References

See the Steam Paper.